

WE CLAIM:

1. A permanent magnet synchronous machine comprising:  
a rotor having a plurality of angularly spaced permanent magnets; and  
a stator having a plurality of axially spaced segments, each segment including windings for generating magnet field components in response to applied AC signals for interaction with the rotor magnets to apply torque to rotate the rotor within the stator and to support the rotor centrally with the stator, the stator windings also being responsive to applied AC signals to produce an axial restoring force to the rotor in response to axial displacement of the rotor away from a selected axial position within the stator.
2. A permanent magnet synchronous machine system in accordance with claim 1 wherein the rotor has a plurality of axially spaced segments and comprising paired rotor and stator segments in which rotor and stator segments are axially offset from each other.
3. A permanent magnet synchronous machine system in accordance with claim 1 wherein the rotor has a plurality of axially spaced segments and comprising axial rotor and/or stator segments that are of different axial or radial dimension and/or power level than that of other axial segments.
4. A permanent magnet synchronous machine system in accordance with claim 1 further comprising at least one power transferring device coupled to a shaft supporting rotor segments.

5. A permanent magnet synchronous machine system in accordance with claim 1 including at least one stator segment powered for torque-applying action and at least one stator segment powered for integrated magnetic bearings action.

6. A permanent magnet synchronous machine system in accordance with claim 1 wherein the stator windings can receive signals to effectuate anti-vibration, torsion, and noise control in the six controllable degrees of freedoms.

7. A permanent magnet synchronous machine in accordance with claim 6 wherein flexural shaft modes are attenuated by forces and/or moments produced by the stator windings.

8. A permanent magnet synchronous machine in accordance with claim 1 including a control unit for supplying AC signals to the windings to generate motor torque, produce magnetic bearing forces for the rotor, and control the axial position of the rotor.

9. A permanent magnet synchronous machine in accordance with claim 1 wherein the rotor is an axially integral component.